UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF EEG EPILEPSY RECOGNITION SYSTEM USING ARTIFICIAL NEURAL NETWORK

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

by

ADILAH BINTI YAHYA

B071710361

960128-05-5042

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: DEVELOPMENT OF EEG EPILEPSY RECOGNITION SYSTEM USING ARTIFICIAL NEURAL NETWORK

Sesi Pengajian: 2021

Saya **ADILAH BINTI YAHYA** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* — Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* — Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

ADILAH BINTI YAHYA

Alamat Tetap:

No. 54 Jalan 9,

Kampung Bukit Temiang,

70200, Seremban, NSDK.

Tarikh: 13 February 2021

Disahkan oleh penyelia:

.....

Ts. KHAIRUL AZHA BIN A AZIZ

Cop Rasmi Penyelia

Ts. KHAIRUL AZHA BIN A AZIZ
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik Dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 14 February 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled DEVELOPMENT OF EEG EPILEPSY RECOGNITION SYSTEM USING ARTIFICIAL NEURAL NETWORK is the results of my own research except as cited in references.

Signature: ……

Author : ADILAH BINTI YAHYA

Date: 13 Februari 2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

Signature: .....

Supervisor : Ts. KHAIRUL AZHA BIN A AZIZ

Ts. KHAIRUL AZHA BIN A AZIZ
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik Dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
Universiti Teknikal Malaysia Melaka

Signature: .....

Co-supervisor: Ts. NADZRIE BIN MOHAMOOD

Ts. NADZRIE BIN MOHAMOOD
Jurutera Pengajar Kanan
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

ABSTRAK

Epilepsi diklasifikasikan sebagai salah satu gangguan berkaitan otak yang mempengaruhi keseluruhan sistem saraf otak dan ini disebabkan oleh gelombang otak yang mengalami perubahan voltan berfrekuensi tinggi, atau disebut sebagai sawan. Penyakit ini adalah salah satu pergerakan tidak terkawal yang dilakukan oleh pesakit epilepsi tanpa sedar. Oleh itu, kajian tesis ini adalah untuk membangunkan sistem pengecaman *epilepsy* dengan menggunakan Rangkaian Neural Buatan (ANN). Teknik Rangkaian *Neural Cascade-forward* digunakan dalam pembelajaran mesin sebagai alat utama untuk melaksanakan proses persis otak manusia. Sistem ini diilhamkan dengan bertujuan untuk mencipta kembali cara pemikiran otak manusia. Tesis ini menggunakan Rangkaian *Neural Cascade-forward* yang sangat mirip dengan Rangkaian *Neural Feed-Forward* dan kemudian prosedur pengecaman epilepsi ini dilaksanakan dengan menggunakan perisian MATLAB. Selain itu, kajian ini juga menggunakan elektroensefalogram (EEG) yang kemudiannya digunakan untuk mendiagnosis dan mengakses aktiviti didalam otak manusia dengan menggunakan set data yang diperoleh dari University of Bonn (UBonn), yang telah banyak digunakan oleh penyelidik lain mengenai kajian epilepsi ini. Penderia MindLink EEG digunakan untuk memperoleh data luaran dari isyarat EEG, yang kemudian diperlukan untuk menguji di jaringan saraf. Hasilnya, sistem ini berjaya dilaksanakan dengan 79.4% untuk ketepatan keseluruhan dengan latihan, pengesahan dan pengujian secara berurutan dengan memperoleh 79.4%, 88.0% dan 70.3%.

ABSTRACT

Epilepsy classified as one of the brain-related disorders affecting the entire brain nervous system and characterized by the high-frequency and high-voltage brain waves, which called as a seizure. This disease recognized as one of the uncontrollable movements made by the epilepsy patients during an outbreak which can cause consciousness and convulsion. Consequently, this thesis studies are to develop EEG Epilepsy Recognition System using Artificial Neural Network (ANN). Cascade-Forward Neural Network technique is used as their primary tools which their system invented to execute a process like a human brain. This brain-inspired system which meant to recreate the way human brains thinks. This thesis uses Cascade-forward Neural Network, which is quite similar to the Feed-forward Neural Networks approach and proposes the epilepsy recognition procedure implemented by using MATLAB software. Additionally, this study also used the Electroencephalogram (EEG) signal which then used to diagnose and accessing human brain activity and disorder by using the dataset obtained from University ofBonn (UBonn), which has been widely used by other researchers regarding epilepsy studies. The MindLink EEG Sensor is used to obtained external data of the EEG signal, which then needed to test in the neural network. As for results, this system successfully carried out with 79.4% for overall accuracy with training, validation and testing sequentially acquire 79.4%, 88.0% and 70.3%.

DEDICATION

This thesis is dedicated to Yahya Bin Yusof and Maszalinah Binti Ruslan, my beloved parents for their constant love, encouragement, and inspiration. To my supervisor Encik Khairul Azha Bin A. Aziz who never giving up to taught and guide me to complete my thesis. To my beloved siblings Masliya Binti Yahya, Yamim Bin Yahya and Marita Binti Yahya who always keep supporting me. To my best friend, Ainnur Annisa Binti Noor Izan, thank you for always be there for me.

ACKNOWLEDGEMENTS

Bismillahirrahmanirrahim,

In the name of Allah, the Most Gracious and the Most Merciful. All the praises to Allah, the Lord of the ‘Alamin (mankind, jinns and all that exists).

First and foremost, Alhamdulillah thanks to Allah for giving me good health, spirit, patience, determination and blessing me far more than I deserve. Without Him I would not be able to complete my dissertation in time.

Secondly, I would like to express my gratitude and appreciation to my supervisor, Encik Khairul Azha Bin A. Aziz for his guidance, support, encouragement, advise and most importantly for not giving up on me during the completion of this thesis.

Last but not least, I sincerely would like to express my thanks to all my beloved friends, for their supports and encourage me to complete this thesis successfully. Without their supports and love, I may have a difficulty to complete my thesis. To all whom ever know me and help me directly and indirectly, thank you so much and may Allah bless us all.

TABLE OF CONTENTS

UTeM
اونيۏرسيتي تيکنيکل مليسيا ملاک
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

taken in the range between ten minutes.

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOLS

μV	Microvolts
α	Alpha
β	Beta
γ	Gamma
Δ	Delta
θ	Theta
Hz	Hertz
V	Volt
dB	Daubechies
ψ	Wavelet coefficients
$\tau\tau$	Tau
VCC	Voltage Common Collector
GND	Ground
RX	Receiver
TX	Transmitter
a	Scaling Parameter
b	Location of the Parameter
%	Percentage

LIST OF ABBREVIATIONS

EEG	Electroencephalogram
MIT	Massachusetts Institute of Technology
CNN	Convolutional Neural Network
CHB	Children's Hospital Boston
CWT	Continuous Wavelet Transform
BoW	Bags-of-Words
SVM	Support Vector Machine
DWT	Discrete Wavelet Transform
FFT	Fast Fourier Transform
AR	Autoregressive or Autoregression
MLPNN	Multilayer Perceptron Neural Network
ANFIS	Adaptive Neuro-Fuzzy Interference System
KDD	Knowledge Discovery in Database
RNN	Recurrent Neural Network
LSTM	Long-Short-Term Memory
GRU	Gated-Recurrent Unit
STFT	Short-time Fourier Transform
WT	Wavelet Transform
GPS	Global Positioning System
ANN	Artificial Neural Network
UBonn	University of Bonn

MATLAB	Matrix Laboratory
GUI	Graphical User Interface
2D	2-Dimensional
WT	Wavelet Transform
DNA	Deoxyribonucleic acid
FC	Fully Connected Layer
ASCII	American Standard Code for Information Interchange
PLX-DAQ	Parallax Data Acquisition
IDE	Integrated Development Environment
ROC	Receiver Operating Characteristic
perf	Performance
COMM	Component Object Model
USB	Universal Serial Bus
Std	Standard Deviation
IoT	Internet of Things
AIS	Artificial Immune Network

CHAPTER 1

INTRODUCTION

1.1 Overview

In reality, this chapter actually explain about the description for a project summary. The contents under this chapter is including Project Background, Statement of the Purposes, Problem Statement and Project Scope. By going through this part, the reader should be able to understand the core concept of this thesis.

1.2 Project Background

Epilepsy is classified as one of the brain-related disorders affecting the entire brain nervous system and it is characterized by the high-frequency and high-voltage brain waves which is called as seizure. These seizure puts patients at a higher risk for injuries such as falls, head injuries, scrape, burns, and many others. This is due to abrupt seizure and leaving the patient without any further notice. This Epilepsy condition affects 50 million people all around the world and mostly 90% of the epilepsy patients live in countries looking to be advance and around three of fourth of them are unable to get the proper and suitable treatment (Hekim, 2012). Until now there is still no cure for the disease and only can be treated with medications and surgery.

Electroencephalogram (EEG) is one of the devices or instruments that specially measures the electrical activities generated by firing of neurons along the scalp within the brain. EEG is a non-invasive, cost effective, well-established, and accurate procedure used to diagnose brain-related disorders such as epilepsy, autism, brain tumours and

depression. EEG reads changes in the brain voltage between electrodes which are positioned on some crucial points of the patient's head with some help of proper mechanical and electrical support. Hence, the EEG signal data collected is send to the main EEG system and saves the signals produced (Alqatawneh *et al.*, 2019).

Epilepsy raw database is obtained from the Department of Epileptology at University of Bonn in Germany (UBonn). The EEG raw dataset then is analysed completely by using Discrete Wavelet Transform (DWT). The DWT then is separated into 8 sub-band frequencies which is delta, theta, low alpha, high alpha, low beta, high beta, high gamma and low gamma. According to the psychological studies, frequency which is more than 60 Hz is regarded as noise and can be neglected (Abdullah, Rahim and Ibrahim, 2012). The method of classifying Artificial Neural Network (ANN) is used to do mathematical processes such as calculation, decision-making, and learning. Based on the human biological nervous system, this model known to be mechanisms for ANN the simulation of biological neural network (Jaafar, Mohamood and Mahdi, 2018).

ANNs are commonly used in the identification of signal groups in many biomedical signal analyses, as they have a greater predictive ability than the techniques of signal analysis. Therefore, they provide useful advice for making a medical diagnosis decision (Hekim, 2012). In this study, we demonstrate analysis of EEG signals using ANN by MATLAB neural network toolbox. The main purpose of this paper to illustrate the potential use of ANN to classify between normal persons and those who suffer from epilepsy by evaluating the EEG parameter data.